4/52

STUDY OF SUGAR PINE LOSSES ON PLOT SP-1

FROM 1941 TO 1950

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INTRODUCTION

Plot SP-1, a 20-acre sugar pine study plot in virgin mixed-conifer type was established in the Mariposa Grove area, Yosemite National Park in May, 1941. This is the only plot set up for specific detailed studies of sufficient size to obtain and evaluate mountain pine beetle losses in sugar pine within a relatively short period of time. With a ten-year record now completed, an appraisal of the information obtained strongly indicates that plot studies of this character will serve as a basic requirement in determining management practices to lessen beetle damage.

The original objective of this study was stated as follows: "to determine what factor or combination of factors within a given area of virgin forest will predispose sugar pine trees to attacks by the mountain pine beetle." Preliminary effort was directed toward a study and establishment of diagnostic tree characters which could be used in recognizing trees susceptible to attack, and in determining the causes of decadence in trees showing signs of deterioration.

This plot was laid out as a rectangle, 10 chains wide by 20 chains long, in an east-west direction. Every tree over 12 inches DBH was marked with a permanent numbered tag, recorded, and classified in accordance with a tentative crown decadence rating set up as a result of detailed observational studies. At the same time each tree was classified according to the Keen and Dunning systems developed for ponderosa pine.

This plot has been checked four times since establishment; in June, 1944; August, 1945; August, 1948; and August, 1950. Each time an accounting was made of mortality due to D. monticolae or other insects, losses due to windfalls, and subsequent mountain pine beetle losses following breeding in windfalls. Other factors observed as contributing to bark beetle attack and mortality were recorded as: site and soil condition; competition with reproduction and stocking; mistletoe infection.

Whereas the losses in number of trees for this period due to mountain pine beetle attacks have not been high, there are several interesting aspects about the character of this loss which appear significant and should be pointed out. They are presented now as a step in planning for further studies leading to better management practices.

AMOUNT AND CHARACTER OF LOSS

The two dominant factors responsible for loss during this period were wind and mountain pine beetle; windfalls accounted for 9 trees and D. monticolae for 8 trees. The following tabulation is indicative of the drain due to these factors from an original stand of 229 trees, having 1,041,670 board feet.

Table 1. Windfall and Bark Beetle Loss on Plot

Loss factor	Total Trees	Total Volume	Per Acre Trees	Per Acre Volume	Percent of Orig. Stand Trees	Percent of Orig. Stand Volume
Windfalls	9	30,680	.45	1,534	3.9	2.9
D. monticolae	8	23,680	.40	1,184	3.5	2.2
Total	17	54,360	.85	2,718	7.4	5.1

The loss due to windfalls occurred during the winters 1941-42, 1943-44, and 1944-45.

Killing by the mountain pine beetle occurred at two distinct intervals; from 1943 to 1945, and 1949 to 1950. In each case both the sources of attack and character of trees attacked are different. The kill of 4 young vigorous trees in 1943-1945 was traceable to large broods known to have developed in windfall material during the period from 1942 to 1944. The kill in 1949 and 1950 of overmature, large-size trees had no apparent association with breeding in windfalls locally (none were found), but appeared to result from attacks by beetles flying in for some distance. There was thus indicated an attraction to these overmature trees in the same immediate locality on the plot.

DISTRIBUTION OF PAST AND PRESENT D. MONTICOLAE LOSSES ON PLOT

The tendency toward attraction and kill of large overmature trees in the same local area was exhibited in the 20-year period prior to the establishment of this plot in 1941 as determined at the time by estimates based on the old stumps left as a result of control work. A glance at the plot map, Figure 1, reveals that most of the past loss shown as stumps, as well as the present killing is confined to a 7½-acre area in the west half of the plot. In this area 25 trees were killed prior to 1941. This amounted to 76 percent of the total trees and an estimated 70 percent of the total volume killed on the entire 20 acres. Again, the kill occurring on the plot during the current 10-year period was confined to these same 7½ acres.

Differences between areas

An examination of the different plot components and some of the factors of a given component may help to explain the evident localized selection of trees killed. Referring to the map, each 2½- acre component is numbered from 1 to 8. The losses are all confined to com-

ponents of 5, 7, and 8. In an attempt to explain why the localized killing occurred several factors are considered.

1. Age of Stand. The distribution by age classes within each 2½-acre component is shown by Table 2. This table shows that 45 percent of the total number of overmature trees on the entire plot are located within the 7½ acres where heavy loss has occurred. This may be a significant factor in the local character of recent killing.

Table 2. Original Sugar Pine Stand Distribution by Age Classes in 2½-acre Components of Plot SP-1

Component No.	Age Class (years) 0-100	100-225	225-350	Over 350	Total Trees	Volume Bd. Ft.
1	3	8	10	3	24	159,920
2	1	16	10	3	30	176,220
3	6	11	9	4	30	176,790
4	4	1	7	6	18	135,290
5	10	16	8	2	36	88,190
6	6	7	5	7	25	103,130
7	21	1	2	9	33	83,600
8	5	8	13	8	34	120,030
Totals	53	68	66	42	230	1,043,270

2. Crown Class and Age of D.m. trees. The trees attacked and killed by D. monticolae as previously mentioned, occurred in two different periods with marked differences in character. Those killed earlier, from 1943-1945, were small, fairly vigorous young trees, growing in close competition. Those killed later were large overmature trees in a fairly open stand. The classes and age of all trees killed are shown in Table 3.

Table 3. Crown Class and Age of D.m. Trees

Tree #	Crown Class Decadence	Keen	Dunning	Age Class (years)	Year Killed	
157	2B	1B	2	0-100	1944-45	W
158	1B	1B	2	0-100	1944-45	W
159	2A	1B	2	0-100	1943-44	W
160	1B	1B	2	0-100	1943-44	W
104	4B	3C	5	Over 350	1950-s	
184	4A	4C	4	" 350	1949-50	W
185	3B	4B	4	" 350	1950-s	
213	4A	4C	5	" 350	1950-s	

It is to be noted that the four more recently attacked trees were over 350 years old, and classified in the last 3 most decadent categories. Thus, it would appear that these over-mature, and more

decadent trees were more susceptible to attacks. However, their location in the same 7½ acres as the higher previous killing strongly suggests that certain local area hazard factors may have been important, and that they were perhaps more adverse in their effect on the older more decadent trees than on the younger more vigorous trees.

3. Soil Character. Since all of the killing took place within the 7½-acre area it is well to consider if soil character may offer an explanation. While no detailed analyses of type or depth of soil have been made, observations of rock outcroppings and depth as indicated from wind-uprooted trees showed that marked differences exist. The 7½-acre area, with extensions west of the plot, covers a ridge top overlain by an old lava deposit. Here the soil is generally shallow, with tree roots matting on rock, a condition which would seemingly affect available moisture, particularly during years of deficient precipitation. Deep, fine, granitic soil appears to be characteristic in the other portions of this plot. Further investigation of this factor should be undertaken along with other records continued on this plot.

4. Precipitation. Records taken during the 5 year period, from 1943 to 1949, start out with low precipitation followed by high, then 5 years of successively lower amounts. No record was taken for the 1949-1950 period, but the records from nearby stations at North Fork and Yosemite Valley were very slightly above the previous year. The plot record is tabulated below. The normal for this general area is approximately 40 inches.

Table 4. Precipitation on Plot, 1943-1950

Year	Inches
1943-44	19.35
1944-45	43.72
1945-46	35.64
1946-47	32.48
1947-48	29.04
1948-49	20.42
1949-50	20.50 (estimated)

This record clearly indicates that moisture may have been a critical factor in the attacks made during 1949-1950, particularly with severe deficiencies shown in the last two years.

5. Mistletoe infection. Witches brooms, prominent through the crowns of older trees, and bunches of mistletoe in the younger trees, is a dominant characteristic in the sugar pines throughout the 7½-acre area. Elsewhere this factor is negligible. Mistletoe appeared to have contributed to dead or dying branches and general decadence among crowns, with subsequent weakening generally in the stand.

Significance

This record serves to point out three factors in common on the

7½ acres of highest killing, which are different from the remaining 12½ acres on the plot. These are: (1) shallow, rocky soil of volcanic origin; (2) large proportion of over-mature trees; (3) mistletoe infection. While precipitation was deficient over the entire plot, this factor was apparently critical only in the volcanic type soil, and was therefore most significant in recent D. monticolae attacks.

While the record from this plot over a 10-year period is perhaps too limited as a base for conclusions, it serves to strengthen our former premise that management practices to control mountain pine beetle losses may best result from recognizing the hazard factors of local areas conducive to outbreaks. Possibly soil moisture is the most critical factor in any outbreak whether it is the result of soil character, excessive competition, or deficient precipitation. Recognition of these factors in stands containing a high proportion of over-mature trees appears to be a primary requisite to utilization before mountain pine beetle outbreaks deplete these values.

FURTHER STUDIES NEEDED

Further information from this plot, and in addition, from 15 additional one-acre plots established in 1943 in different areas, should strengthen our basis for conclusions. Additional areas should be established and recorded for a period of years as an adequate measure of the significance of hazard. These should be set up on a basis similar to those already established, giving emphasis particularly to soil character, age of stand, and competition. Site index is not a significant factor in sugar pine management to control D. monticolae inasmuch as this insect is equally important as a killer in all sites. Crown decadence characteristics likewise, do not appear to offer much promise of significance in general as an indicator of susceptibility.

FIGURE 1

U.S.D.A.

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

PLOT SP-1

SUGAR PINE INSECT SUSCEPTIBILITY STUDY

SCALE - 1 INCH = 2-1/2 CHAINS